

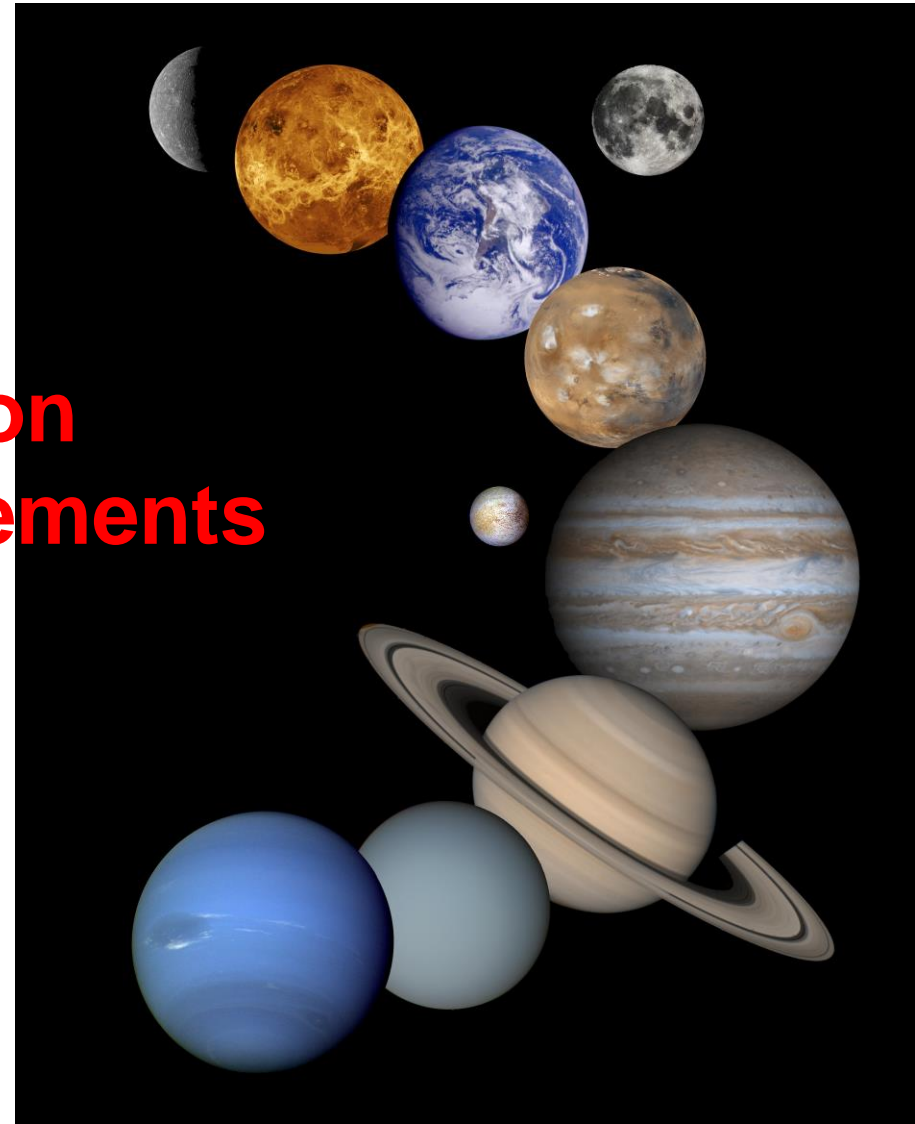
Planetary Protection: Policies and Practices



Tutorial Session 2

Planetary Protection Policy and Requirements

G. Kminek and C. A. Conley
June 2015



It is not about asteroid/planetary defense

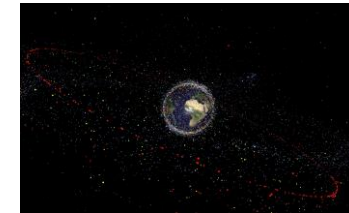
- Covered under Near Earth Objects and Space Situational Awareness Programs



Fireball exploded above Chelyabinsk city in the morning of 15 Feb. 2013

It is not about space debris

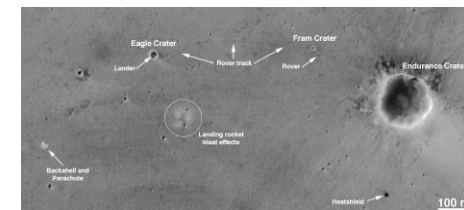
- Covered by UN-COPUOS space debris mitigation guidelines
- International coordination through the Inter-Agency Space Debris Coordination Committee (IADC)



Space Debris Image: ESA

It is not about cultural or natural world heritage

- Covered by UNESCO based on a convention (for Earth) and the COSPAR Panel on Exploration (for space)



MER on the surface of Mars: NASA

It is not a green party for space



Credit: Mars Daily

It is not about playing around with guns and ET



Credit: Sony Pictures

Ensure that scientific investigations related to the origin and distribution of life are not compromised

- *Enabling capability*
- *Protect our investment in space science & exploration*

Protect the Earth from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission

- *Simple prudence - protect the Earth!*
- *In line with the precautionary principle of environmental protection*



Science class should not end in tragedy....
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Science class should not

Bart Simpson, Dec. 17, 2000, "Skinner's Sense of Snow"

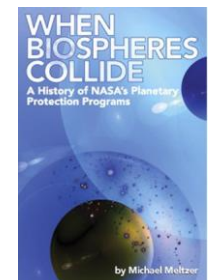
"...we are in the awkward situation of being able to spoil certain possibilities for scientific investigations for a considerable interval before we can constructively realize them...we urgently need to give some thought to the conservative measures needed to protect future scientific objectives on the moon and the planets..." J. Lederberg and D. B. Cowie, *Science*, 1958



- Reflects the concern raised by the International Astronautical Federation (IAF), UN-COPUOS and US National Academy of Science (NAS) in this time period that lead to the Committee on Contamination by Extraterrestrial Exploration (CETEX), established by the International Council of Scientific Unions (ICSU)
- ICSU adopts the CETEX Code-of-Conduct and established the Committee on Space Research (COSPAR)
- COSPAR established the Consultative Group on Potentially Harmful Effects of Space Experiments
- The first spaceflight missions to use this Code-of-Conduct were the Ranger missions in 1961
- Since then, all planetary missions had to implement planetary protection measures at different degrees – ranging from simple documentation to terminal sterilization of entire flight systems
- More detailed quantitative regulations, in particular for Mars, were adopted by COSPAR in 1964 (e.g., C. Sagan and S. Coleman, *Astronautics & Aeronautics*, 1965; C. Sagan, E. C. Levinthal, J. Lederberg, *Science*, 1968)



Credit: NASA SP 4210



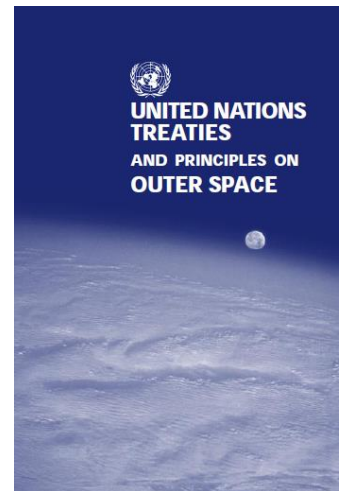


Framework for Planetary Protection



The legal basis for planetary protection was established in Article IX of the United Nations Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (Outer Space Treaty)

"...parties to the Treaty shall pursue studies of outer space including the Moon and other celestial bodies, and conduct exploration of them so **as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter** and, where necessary, shall adopt appropriate measures for this purpose..."





COSPAR Planetary Protection Policy



COSPAR maintains and promulgates a planetary protection policy for the reference of spacefaring nations, both as an international standard on procedures to avoid organic constituent and biological contamination in space exploration, and to provide accepted guidelines and requirements in this area to guide compliance with the wording of the Outer Space Treaty

"The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized. In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission. Therefore, for certain space mission/target planet combinations, controls on contamination shall be imposed in accordance with issuances implementing this policy."

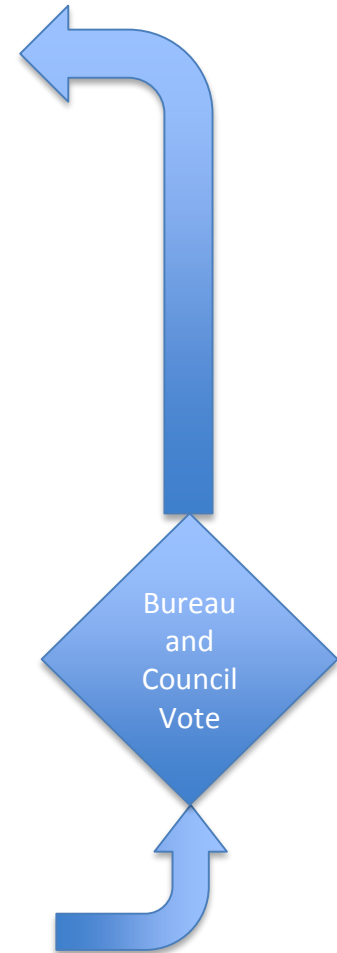




Updating the Planetary Protection Policy



- **COSPAR Planetary Protection Policy**
(COSPAR Bureau- and Council-endorsed version)
- **New phenomena reported/new missions proposed/other external considerations**
(Peer reviewed scientific literature/request from private or public entity/recommendations from agency advisory groups)
- **Possible study by a scientific organization and/or a COSPAR-sponsored workshop**
(May be solicited by space agencies and carried out by a National Scientific Institution or International Scientific Unions)
- **Panel on Planetary Protection meeting**
(Panel business meeting at COSPAR Scientific Assemblies or dedicated COSPAR Panel Colloquium, involving representatives of the scientific community and other relevant stakeholders)
- **Panel recommendation to Bureau & Council**
(At COSPAR Scientific Assemblies or at COSPAR Bureau meetings between Assemblies)





Earth Return Missions



A comprehensive Lunar Quarantine Program, including an Interagency Committee on Back Contamination (ICBC), has been established to “protect the public’s health, agriculture and other living resources” (NASA SP 368)

When MSC asked whether the PHS's immigration officers would allow the Apollo astronauts to enter the United States if they were handled in the same way the Gemini crews had been, the reply was emphatic: they would not (NASA SP 4214)



Credit: NASA/Apollo 11

“...samples returned from Mars by spacecraft should be contained and treated as though potentially hazardous until proven otherwise. No uncontained martian materials, including spacecraft surfaces that have been exposed to the martian environment, should be returned to Earth unless sterilized.” (NRC, 2009)



“To ensure independent oversight throughout the lengthy and complex process of planning and implementing a Mars sample return mission, planetary protection policy and regulatory oversight for all aspects of sample return should be provided by both the PPS (or an equivalent group) and the NASA PPO, each having suitable authority and accountability at an appropriate administrative level within NASA.”(NRC, 2009)



Current COSPAR planetary protection principles for human Mars missions:

- The intent of planetary protection is the same whether a mission to Mars is conducted robotically or with human explorers
- Safeguarding the Earth from potential back contamination is the highest planetary protection priority in Mars exploration
- The greater capability of human explorers can contribute to the exploration of Mars only if human-associated contamination is controlled and understood
- One of the critical issues: for Apollo the preservation of human life took precedence over the quarantine

The next steps:

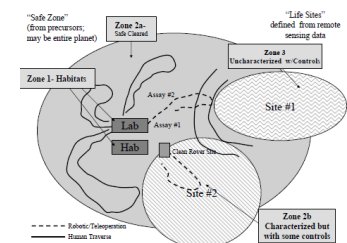
- Develop detailed requirements (started under NASA leadership)
- Develop technical solutions (e.g., life support system, clean egress and ingress capability, waste management, in-flight quarantine capabilities, medical and biological status monitoring, in-flight decontamination capabilities)
- Develop operational concepts (e.g., contamination transport, robotic scouts, stay-out zones)



Credit: ESA



Credit: NASA/Apollo 12



Do we want those neighbors?





Coordination on Planetary Protection



UN-COPUOS
IAA
COSPAR
ESA Letter
of Agreement
US-NRC/SSB

- International Relations
- Legislative Affairs
- General Council
- State
- OSTP **Policy**

Outside NASA
Inside NASA

- Science Mission Directorate
- Human Exploration & Operations
- Space Technology

- CDC
- USDA
- DHS
- EPA

Technology

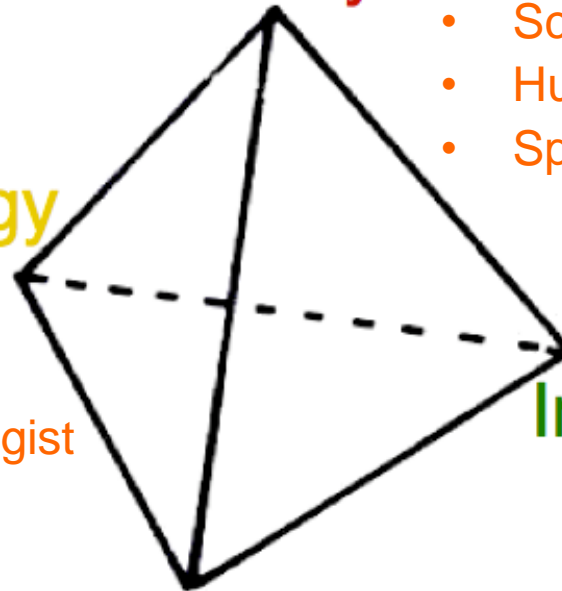
- Chief Engineer
- Chief Scientist
- Chief Technologist

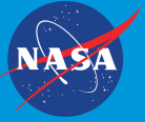
- NSF
- NIH
- USGS
- DOE

Science

Implementation

- FAA
- Commerce
- Chief Health and Medical Officer
- Safety and Mission Assurance





ESA-NASA Cooperation



- In 2007, ESA and NASA signed a formal Letter of Agreement on planetary protection, under which the agencies agree to:
 - cooperate on policy studies and conduct technical research
 - consult and collaborate on training and education
 - exchange goods, documents, reports, and advice
 - facilitate visits by personnel to facilities and internal meetings
- Under this agreement, NASA and ESA share research results to complete ongoing work
 - bioburden assays and accounting approaches/inventory
 - sterilization modalities
 - standard procedures for performing technical work
- Letter of agreement enables joint development of planetary protection approaches for Mars Sample Return (*e.g., take lessons learned from past missions...*)



NASA Planetary Protection Policy



- The policy and its implementation requirements are embodied in NPD 8020.7G (*approved by NASA Administrator*)
 - The Planetary Protection Officer acts on behalf of the Associate Administrator for Science to maintain and enforce the policy
 - NASA obtains recommendations on planetary protection issues (requirements for specific bodies and mission types) from the National Research Council's Space Studies Board
 - Advice on policy implementation is obtained from the NAC Planetary Protection Subcommittee
- Specific requirements for robotic missions are embodied in NPR 8020.12D (*approved by SMD Associate Administrator*)
 - Encompasses all documentation and implementation requirements for forward and back-contamination control
- General guidelines for human missions are outlined in a NASA Policy Instruction, NPI 8020.7 (*approved by AAs, SMD and HEO*)
- Complies with COSPAR policy: NASA supports international missions only if COSPAR policy is followed



NASA Planetary Protection Policy

(from NPD 8020.7)



- “The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized.”
 - Preserves science opportunities directly related to NASA’s goals, and can support certain ethical considerations; originally recommended to NASA by the NAS in 1958
 - Preserves our investment in space exploration
 - Can preserve future habitability options
- “The Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from another planet.”
 - Preserves Earth’s biosphere, upon which we all depend...
- Assignment of categories for each specific mission/body is to “take into account current scientific knowledge” via recommendations from advisory groups, “most notably the Space Studies Board.”



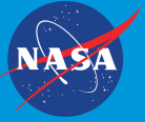
“Current Scientific Knowledge”

(NPD 8020.7)



- Planetary Protection constraints “will take into account current scientific knowledge about the target bodies through recommendations from both internal and external advisory groups”
 - “Most notably” the Space Studies Board of the NRC
 - *provides recommendations on high-level policy and requirements*
 - Internally, the Planetary Protection Subcommittee of the NASA Advisory Council (formerly the Planetary Protection Advisory Committee)
 - *provides programmatic advice and detailed advice on implementation for individual missions*
 - *includes representatives from other US agencies and international space agencies*





Agency level: Science Mission Directorate

5.a. The Associate Administrator for the Science Mission Directorate, or designee, is responsible for overall administration of NASA's planetary protection policy. This includes the following:

- (1) Maintaining the required activities in support of the planetary protection policy at NASA Headquarters.
- (2) Assuring that the research and technology activities required to implement the planetary protection policy are conducted.
- (3) Monitoring space flight missions as necessary to meet the requirements...

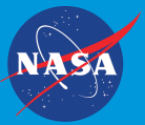
5.b. The Planetary Protection Officer is the designee of the SMD AA... (next slide)

Centers and Project level:

5.c. The Associate Administrator for the Human Exploration and Operations Mission Directorate and the Associate Administrator for the Space Technology Mission Directorate, or designees, will ensure that applicable standards and procedures established under this policy, and detailed in subordinate implementing documents, are incorporated into human space flight missions.

5.d. Program Managers.... are responsible for the following:

- (1) Meeting the biological and organic contamination control requirements of this directive...
- (2) Providing for the conduct of reviews, inspections, and evaluations by the Planetary Protection Officer...



Planetary Protection Officer Role (NPD 8020.7)



Designee of the SMD Associate Administrator,
responsible for planetary protection:

- Prescribes standards, procedures, and guidelines applicable to all NASA organizations, programs, and activities to achieve policy objectives
- Certifies to the SMD AA that missions are compliant
 - Before launch
 - If returning samples, before initiating return and again before Earth entry
- Conducts reviews, inspections, and evaluations of personnel, plans, facilities, equipment, procedures, and practices of NASA organizations and contractors
- Keeps the SMD AA (and, as appropriate, the Administrator) informed of developments, and takes action to ensure compliance with applicable NASA policies and requirements



MIIB™



Requirements per NPR 8020.12



- Some documentation required for all extraterrestrial ***planetary*** missions – not required for heliocentric or Earth orbiting missions
- Schedule and Contents for robotic missions per NPR 8020.12D
- Required documents and contents dependent on mission category
- Additional mission-specific documentation and requirements can be imposed/negotiated during project interactions with PPO



Planetary Protection Considerations for Robotic and Human Missions



- Avoid contaminating target bodies that could host Earth life (e.g., Mars, Europa, Enceladus)
- Ensure biohazard containment of samples returned to Earth from bodies that could support native life (e.g., Mars and possibly moons, Europa, Enceladus)
- On human missions, characterize and monitor human health status and microbial populations (flight system microbiome) over the mission time, to support recognition of alterations caused by exposure to planetary materials



Earth's Moon,

Most Solar System Bodies

Documentation only;
No Operational Constraints on *in situ* activities or sample return



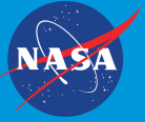
Phobos/Deimos

Document *in situ* activities;
Possible return constraints



Mars, Europa, Enceladus

Documentation and operational restrictions to avoid introducing Earth life;
Strict biohazard containment of returned samples



General Requirements Protecting Targets that could Host Earth Life



Mars Impact Avoidance: For all launch vehicle elements leaving Earth's orbit, the probability of impacting Mars shall be less than 1×10^{-4} for a period of 50 years.

For launched elements possibly encountering Europa, Enceladus, or other objects with potential habitats for Earth life, the relevant probabilistic requirement applies: a 1×10^{-4} probability of contamination *per mission*



PPO Monitoring/Audit Activities



- Evaluate pre-project studies
- Provide formal mission categorization
- Establish detailed requirements definition
- Assist with implementation strategies
- Perform document review and approval
- Monitor project through formal and informal PP reviews
 - Project-specific analyses and reports
 - Recontamination analyses
 - Biological assays (verification)
 - Requests for waivers/deviations (not easy!)
 - Certification of compliance for launch
 - Earth Safety Analysis prior to Restricted Earth Return

Following launch, spacecraft operations are monitored, including review and approval of extended mission operations as well as final disposition of hardware

If you're going somewhere to look for life...



W. Peet, 1974

Don't trash the place (or samples)
before you have a chance to find it!